INPE Nowcasting system: Steps toward an automatic severe storm forecasting system in Brazil

Calheiros, AJP*; Machado, LAT; Stephan, S.; Vila, D.; Santos, R. et al

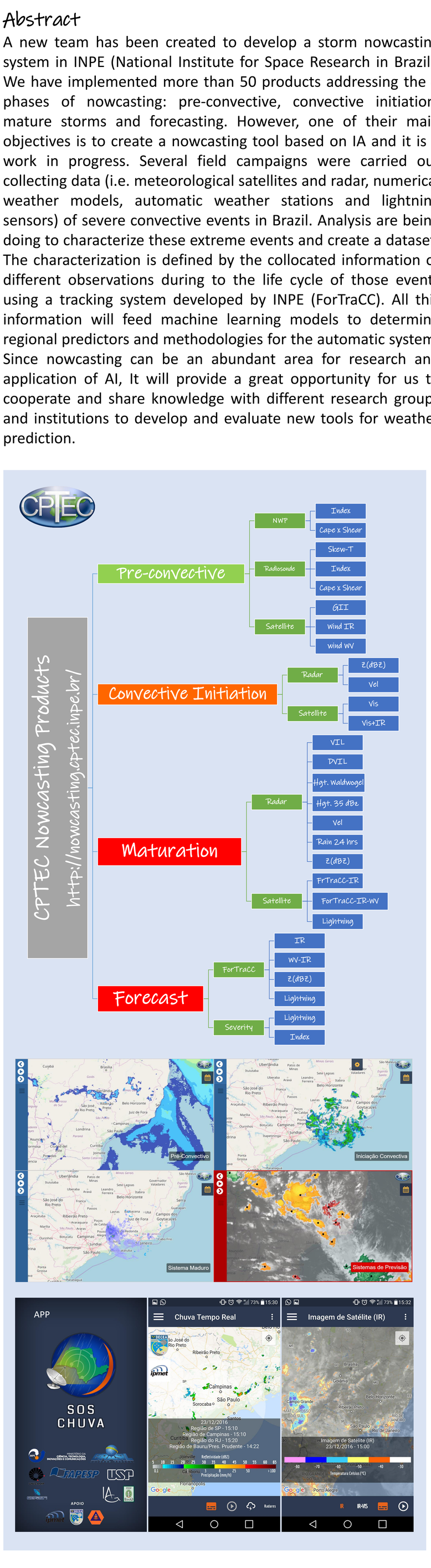
* alan.calheiros@inpe.br

National Institute for Space Research (INPE)

The First NOAA Workshop on Leveraging AI in the Exploitation of Satellite Earth Observations & Numerical Weather Prediction will be held April 23-25, 2019 at NCWCP In College Park, Maryland

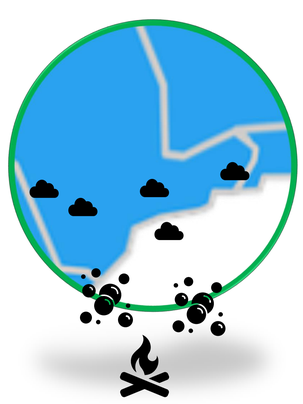
Abstract

A new team has been created to develop a storm nowcasting system in INPE (National Institute for Space Research in Brazil). We have implemented more than 50 products addressing the 4 phases of nowcasting: pre-convective, convective initiation, mature storms and forecasting. However, one of their main objectives is to create a nowcasting tool based on IA and it is a work in progress. Several field campaigns were carried out collecting data (i.e. meteorological satellites and radar, numerical weather models, automatic weather stations and lightning sensors) of severe convective events in Brazil. Analysis are being doing to characterize these extreme events and create a dataset. The characterization is defined by the collocated information of different observations during to the life cycle of those events using a tracking system developed by INPE (ForTraCC). All this information will feed machine learning models to determine regional predictors and methodologies for the automatic system. Since nowcasting can be an abundant area for research and application of AI, It will provide a great opportunity for us to cooperate and share knowledge with different research groups and institutions to develop and evaluate new tools for weather prediction.



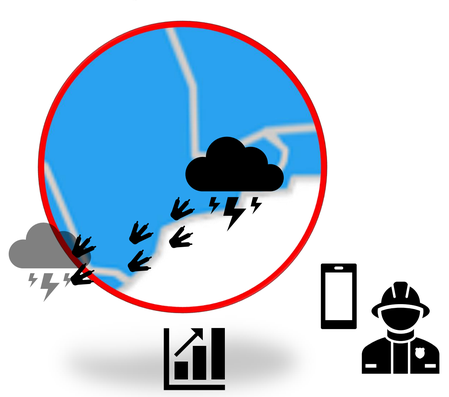
Phases:

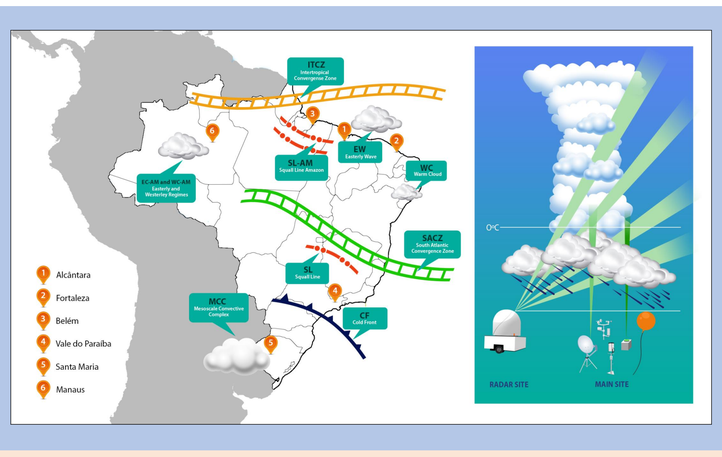
1. Pre-convective condition?



2. Convective initiation?

3. Storm! Severe? And 4. Let's tracking and predict...





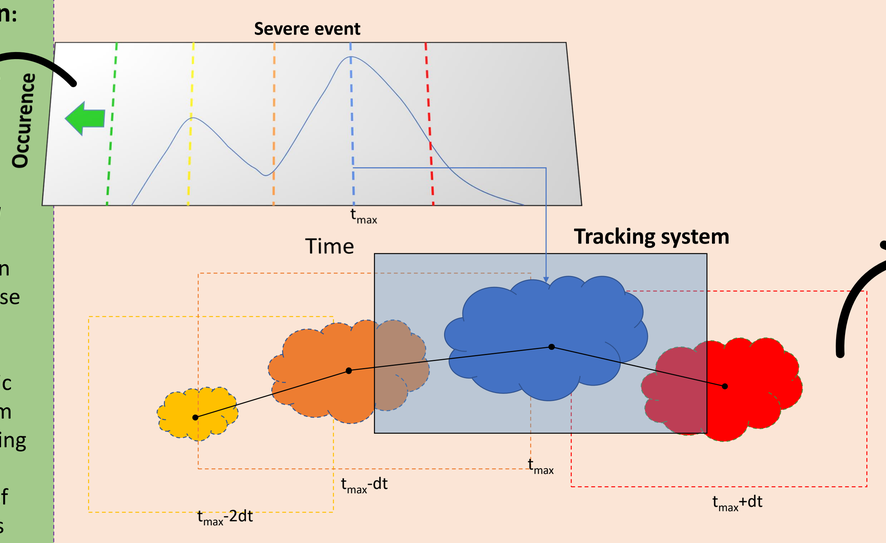
Dataset to training: CHUVA Project, GO-Amazon, SOS-CHUVA

Preliminary Results:

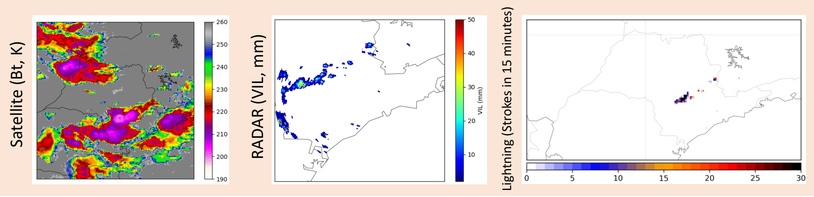
Pre-Convective Prediction:
Satellite
NWP
observations

- *Prediction of convective activity and/or electrical discharge occurrence using numerical model forecasts (Almeida et al, accepted)*: In this approach, training phase employs electric discharge data, machine learning algorithm is either a specific neural network or a random forest. Tests performed using numerical models ETA and BRAMS for antecedences of 24 to 72 hours. Approach is currently being refined in order to undergo further tests and validation.
- Different studies are carrying out to develop new tools to predict the pre-convective condition based on machine learning techniques using WRF as well.

Next approach:

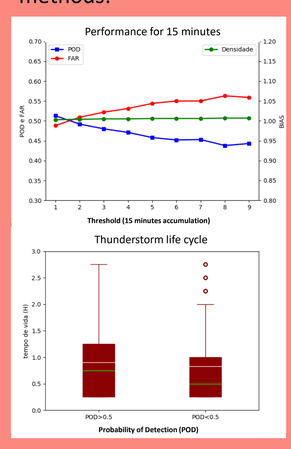


We are looking at the storm lifecycle to create a new forecast model based on different data sources: satellite, radar, lightning sensors and NWP in high resolution.



Forecasting System: Lightning

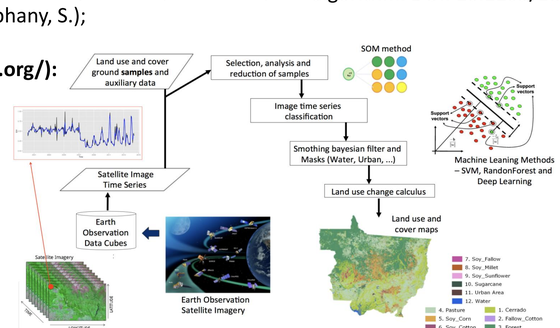
- Lightning forecasting system based on extrapolation methods:



- Both the thresholds and the life cycle of the systems are affecting the forecasts.

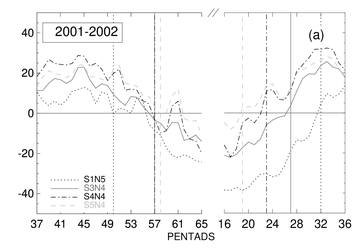
Examples of AI in INPE:

- **EDDA** - Estimation of density of electrical discharge occurrences; Cesar Strauss, Stephan Stephany. This licenced software generates a smooth spatio-temporal field of density of occurrence of electrical atmospheric discharges using kernel estimation according to user-defined parameters like smoothing parameter or integration time period. (DOI: 10.1016/j.atmosres.2013.07.008). Followed by **EDDA-G** (DOI: 10.1016/j.atmosres.2013.07.008) and **EDDA-chuva** (Estimation of convective precipitation, DOI: 10.1002/asl2.453, : Garcia, JVC., Strauss, C., Stephany, S.);
- **e-sensing (http://www.esensing.org/):**



- Spatio-Temporal Segmentation Applied to Optical Remote Sensing Image Time Series. Wanderson S Costa, Leila Fonseca, Thales Sehn Körting, Hugo N Bendini, Ricardo CM de Souza. This is a method for image segmentation applied to time series of the Earth Observation data, in which we adapted the traditional region growing method to detect homogeneous regions in space and time combining image processing techniques and the Dynamic Time Warping (DTW) algorithm. DOI: 10.1109/LGRS.2018.2831914;

The Largescale Teleconection by Complex Network (ComplexNet FAPESP: 11/50151-0) and Automatic Onset monsoon algorithm (Garcia, S.R., Calheiros, A.J.P. & Kayano, M.T. Theor Appl Climatol (2016) 126: 481. https://doi.org/10.1007/s00704-015-1599-3):



Acknowledgments:

CNPq 438310/2018-7